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Seasonal variation in nutritional status and anemia among lactating mothers in two agro-ecological zones of rural Ethiopia: A longitudinal study

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ABSTRACT

Objective: The aim of this study was to determine seasonal and agro-ecological variations in nutritional status, anemia, and associated factors among lactating women in rural Ethiopia.
Methods: We conducted a longitudinal study with 216 mothers in pre- and postharvest seasons in two agro-ecological zones of rural Ethiopia. We conducted interviews using a structured questionnaire, anthropometric measurements, and blood tests for anemia. We used multivariable linear regression models to identify independent predictors.
Results: The prevalence of anemia increased from postharvest (21.8%) to preharvest seasons (40.9%). Increases were from 8.6% to 34.4% in midland and from 34.2% to 46.3% in lowland agro-ecological zones. Of the mothers, 15% were anemic during both seasons. The prevalence of undernutrition, assessed using body mass index (BMI) < 18.5 kg/m^2, increased from 41.7% to 54.7% between the two seasons. Prevalence of maternal mid upper arm circumferences <22 cm also increased from 43.1% to 55.2% during the preharvest season. The seasonal effect was generally more pronounced in the midland community for all forms of malnutrition. Predictors of anemia were high parity of mother and low dietary diversity. Parity, number of children under the age of 5 y, and regional variation were predictors of low BMI among lactating mothers.
Conclusion: The magnitude of malnutrition and anemia was significantly influenced by variations in season and agro-ecological zones. Interventions focused on agro-ecology and seasonal variation should be considered in addition to current strategies to alleviate malnutrition in lactating mothers.

Introduction

It is estimated that about 1.62 billion individuals are affected by anemia globally. The highest burden (90%) of cases exists in low-income countries. It is estimated that, globally, anemia affects 47.4% of preschool children, 42% of pregnant women, and 30% of nonpregnant women. In Africa, 64.6% of preschool children, 55.8% of pregnant women, and 44% of nonpregnant women are anemic [1].

At least 50% of anemia globally is due to iron deficiency (ID). ID is predominantly caused by a deficiency in bioavailable dietary iron; increased iron demands such as during childhood, pregnancy, and lactation; or a combination of the two [2]. A high demand for iron during menstrual blood loss, pregnancy, lactation, and owing to nutritional deficiencies are the most common causes of ID in reproductive-aged women [3,4]. Nutritional requirements during lactation are greater than during pregnancy. A nursing mother produces 0.7 to 0.8 L/d of milk. This requires an extra energy expenditure of at least 2090 kJ/d [5]. The quality of breast milk

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is only affected in extreme cases of deficiency, or by excessive consumption of particular food items [6]. Nonetheless the quantity of milk very much depends on the mother's diet. Food consumed by a nursing mother not only fulfills her nutritional demands, but also enables her to produce milk for her baby [5]. Severely malnourished mothers have reduced lactation performance that contributes to the increased risk for child mortality [7].

Lactating mothers from low-income settings are considered a nutritionally vulnerable group [8]. Low-income setting was estimated to be an underlying factor for 22% of maternal deaths worldwide, of which severe anemia is a major contributor [9,10]. In Ethiopia, 27% of women are undernourished or thin (body mass index [BMI] $<$18.5 kg/m^2). Similarly, 17% of mothers are anemic, of which 19% of lactating mothers are anemic [11]. According to a study conducted in Ethiopia [12], the prevalence of anemia was 17%. The prevalence of anemia among lactating mothers in a slum in Addis Ababa was 22% [13].

To our knowledge there have not been any studies focusing on seasonal variation of anemia and nutritional status among women in Africa, particularly in Ethiopia. The few studies conducted among lactating mothers in Ethiopia were cross-sectional in design and focused on one geographic location and season. Research that documents seasonal and agro-ecological variations in lactating mothers' nutritional status is lacking. This study was carried out to provide information regarding the nutritional status including prevalence of anemia among lactating women in two agro-ecological zones of rural Ethiopia during both the post- and preharvest seasons in line with the wishes of the funding agency (Irish Aid).

Materials and methods

Study setting and participants

The study was conducted in the Babile, Endreta, and Hintalo Wajirat districts of Ethiopia from January to February 2014 (postharvest season) and from July to August 2014 (preharvest season). Babile District (Woreda), which is 560 km away from Addis Ababa in the eastern part of Ethiopia, represented a lowland agro-ecological zone. The altitude of Babile Woreda ranges from 950 to 2000 m above sea level. Data were collected from 1000 to 1500 m above sea level. The major agricultural product for consumption was sorghum, and oil seeds and groundnuts are used as cash crops. Hintalo Wajirat and Endreta districts are 683 and 773 km away from Addis Ababa in the northern part of Ethiopia, respectively, and represent midland agro-ecological zones. Data were collected from altitudes $>$2000 m above sea level where the majority produce cereals (Teff and barley) and are involved in animal husbandry.

A community-based longitudinal study was conducted in four randomly selected kebeles (smallest administrative units in Ethiopia) from each geographic district. We included 216 mother–child pairs in the study. Mothers were selected randomly from a registration list available in each kebele and used by researchers to verify maternal and child age and current feeding status. After identifying mothers who had children between the ages of 6 and 24 mo, mothers who were breast-feeding at the time of the survey were randomly selected with proportional to size allocation for each kebele.

Measurements

Dietary assessment

Dietary diversity was measured using a tool developed by Food and Nutrition Technical Assistance Project (FANTA) [14,15]. A simple questionnaire allowed all types of foods consumed during each of the previous 24 h to be noted. Each woman involved in the study was asked to recall all the communal dishes she had eaten inside and outside the compound during the previous 24-h period. The recall was randomly made on weekdays or on weekend days because weekends do not have any special significance with respect to dietary intake in the context of our study. We took care not to include atypical days (local feasts or celebrations) in the recall.

Anthropometric data

The anthropometric measurements were performed on mothers using the standardized procedures recommended by the World Health Organization (WHO) [16–18]. Weights of the lactating women were measured to the nearest 0.1 kg on a battery-powered digital scale (Seca 770, Hanover, Germany) with a weighing capacity of 0 to 140 kg and heights were measured to the nearest 0.1 cm using a wooden height-measuring board with a sliding head bar following standard anthropometric techniques [19]. Mid upper arm circumference (MUAC) was also measured using a nonstretchable MUAC tape (MUAC measuring tape/PAC-50) [19] on the left upper arm of the mothers. To measure weight and height, study participants removed their shoes and jackets and wore light clothing. To avoid variability among the data collectors, all the anthropometric measurements were taken by two different data collectors and compared. In the case of variation among the data collectors, the principal investigator took the measurement again for validation. The BMI [weight/height^2 (kg/m^2)] was calculated and the threshold of 18.5 kg/m^2 was used to identify underweight women.

Hemoglobin measurement

A trained nurse and a lab technician collected a blood sample from the tip of each mother's middle finger after the site was cleaned with disinfectant. The third drop of blood was added to the cuvettes for measuring hemoglobin (Hb) concentration after two drops were wiped away. The accuracy of this procedure for estimation of Hb in a resource-poor setting has been previously established [20]. Hemoglobin levels of the mothers were tested immediately on site by using a portable HemoCue analyzer (HemoCue® Hb 301). Hemoglobin values were adjusted for altitude using correction factors at every 500 m for altitudes $>$1000 m above sea level [21]. The threshold criteria used to determine the severity of anemia as a mild, moderate, or severe public health problem were prevalence of 5% to 19.9%, 20% to 39.9% and $>$40%, respectively. The cutoff point for anemia was based on the WHO (2011) recommendation for mothers and categorized as mild anemia (Hb 10–11.9 g/dL), moderate anemia (Hb 7–9.9 g/dL), and severe anemia (Hb $<$ 7 g/dL) [21].

Data collection and quality control

The questionnaire was prepared first in English then translated to Tigrigna and Afan Oromo language; data collectors were native speakers of the languages. The process of data collection was overseen by supervisors and the principal investigator. Sufficient data collectors, good organization, and excellent cooperation from local authorities greatly facilitated the efficient conduct of this study. Data were collected by 10 data collectors, together with 10 assistants for carrying measuring board and scale. Three to five guides from each selected community assisted in rapidly locating the selected households. Each team collected data from two households per day and occasionally from three. Data collectors were trained for 5 d before the first round of data collection and for 4 d before the second round. The same data collectors were employed for the second round. Two vehicles were used to facilitate the progress of data collection with the capacity of carrying 12 to 15 passengers. Letters of support and ethical clearances from Haramaya University and National Science and Technology Ministry research and ethical review committee were sent to all concerned local bodies before actual data collection which facilitated very cooperative and supportive interactions. In the second round of data collection the households were already identified, data collectors knew all the localities very well from the first round, and lessons learned from the first round facilitated more rapid and efficient data collection in the second round.

A pilot survey was conducted on 5% of the total sample size in another rural area, which has similar characteristics, and problems identified during the pilot survey were corrected before the start of the actual survey. Two different measurements were taken for the height, weight, and MUAC by two different measurement takers for every participant. The average of the two was considered for the analysis if there was variation in measurements. Finally, the principal investigator was responsible for coordination and supervision of the overall data collection process.

Dependent variables were anemia and nutritional status of lactating mothers. The independent variables were the sociodemographic and economic status, health status of mothers, water, sanitation, health services utilization, and cultural and social characteristics related to the mother's feeding style. Women's Dietary Diversity Score (WDDS) and meal frequency, maternal and child health service utilization, and health-seeking behavior of the family were also assessed.

Data processing and analysis

Data entry and cleaning were coordinated by the first author (KT) in Haramaya University in Ethiopia in compliance with procedures agreed with the other three co-authors. Data analysis using appropriate statistical software and manuscript preparation were conducted in University College Cork in Ireland and involved all authors.

The data were double entered by separate data clerks into EPI Data version 3.1. Data cleaning and editing were undertaken before analysis. For analysis, data were transferred to SPSS (v.16.0) statistical packages and Stata (v.11). The independent variables entered in the multivariable logistic regression model were grouped as sociodemographic information including age, education, family size and number of children less than age 5 y, water source, own toilet, and hand-